Cybersecurity in Manufacturing

8499 36 weeks

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Acknowledgments

The following industry representatives and educators served on the curriculum development panel:

George Bishop, Battlefield High School, Prince William County Public Schools
Jianhua J. Chen, IT Enterprise Architect, Dominion Resource Services, Inc.
Gail Drake, Battlefield High School, Prince William County Public Schools, and Associate Professor, Northern Virginia Community College
Jacob Leonard, Page County High School, Page County Public Schools
Olimpia Stein, Heritage High School, Newport News Public Schools

Jacqueline Rather-Terry, Cumberland High School, Cumberland County Public Schools
Christopher Truong, Norfolk Technical Center, Norfolk Public Schools
Ken Vrooman, IT Specialist, Department of Homeland Security
Christian Walsh-Chase, IT Risk Analyst, Micron Technology, Inc.

Correlations to the Virginia Standards of Learning were reviewed and updated by:
Norma J. Bonney, Kempsville High School, Virginia Beach City Public Schools
Anne F. Markwith, New Teacher Mentor, Gloucester County Public Schools
Cathy Nichols-Cocke, PhD, Fairfax High School, Fairfax County Public Schools
Caroline C. Wheeler, M.T., Secondary English, Richmond

The framework was edited and produced by the CTE Resource Center:
Debi F. Coleman, Writer/Editor
Heather A. Widener, Writer/Editor
Kevin P. Reilly, Administrative Coordinator

Dr. Lynn Basham, Specialist, Technology Education and Related Clusters
Office of Career, Technical, and Adult Education
Virginia Department of Education

Dr. Tricia S. Jacobs, CTE Coordinator of Curriculum and Instruction
Office of Career, Technical, and Adult Education
Virginia Department of Education

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Course Description

Suggested Grade Level: 10 or 11 or 12
Prerequisites: 6302

This course will emphasize manufacturing systems, safety, materials, production, business concepts, and the manufacturing process. Students will learn the principles of cybersecurity, explore emerging technologies, and examine threats and protective measures. Students will participate in enterprise team activities to create products that demonstrate elements of business and manufacturing while demonstrating cybersecurity concepts and policies, including risk management.

Task Essentials Table

- Tasks/competencies designated by plus icons (⊕) in the left-hand column(s) are essential
- Tasks/competencies designated by empty-circle icons (○) are optional
- Tasks/competencies designated by minus icons (⊖) are omitted
- Tasks marked with an asterisk (*) are sensitive.

Task Number	8499	Tasks/Competencies
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43	⊕	Explain the universal systems model (i.e., input, process, and output).
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54	⊕	Explain a programmable logic controller (PLC).
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56	⊕	Differentiate between open and closed loops in control systems.
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Exploring the Evolution of Manufacturing			
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63	⊕	Distinguish among types of ethical concerns in cybersecurity.	
64	⊕	Identify laws/regulations applicable to cybersecurity.	
65	⊕	Differentiate between ethics and laws.	
66	⊕	Identify concepts related to copyright, public domain, copy protection, intellectual property, and licensing agreements.	
Exploring Vulnerabilities, Risks, and Threats in Manufacturing Systems			
67	⊕	Define *risk*.	
68	⊕	Analyze risks affecting the 16 critical infrastructure sectors.	
69	⊕	Describe the characteristics of vulnerabilities.	
70	⊕	Describe the cybersecurity threats to a manufacturing system.	
71	⊕	Describe the cyberattack surface of the standard equipment that connects the manufacturing system and the enterprise's integrated IT system.	
72	⊕	Describe the cyberattack surface of manufacturing systems.	
73	⊕	Describe the cyberattack surface of the manufacturing supply chain.	
Managing Risks in Manufacturing			
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75	⊕	Explain the importance of creating and enforcing plans, policies, and procedures to manage risk.	
76	⊕	Identify the concepts of cybersecurity risk management.	
77	⊕	Identify prevention of and protection systems against cyber threats in manufacturing.	
78	⊕	Identify prevention of and protections against threats throughout each stage of the manufacturing process.	
79	⊕	Explain the importance of physical security controls.	
80	⊕	Describe appropriate incident response procedures.	
Practicing Safety in Manufacturing			
81	⊕	Use required personal protective equipment (PPE).	
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84	⊕	Operate lab equipment according to instructor guidelines.	
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86	⊕	Plan a product.	
87	⊕	Identify a business team for product development.	
88	⊕	Design a product using CAD.	
89	⊕	Design the process for product creation using automation.	
90	⊕	Identify trade secrets and proprietary information of a manufacturing enterprise.	
91	⊕	Identify the prevention of and protections against cyber threats for a manufacturing enterprise.	
92	⊕	Secure the product using cybersecurity best practices.	
93	⊕	Create product.	

Legend: ⊕Essential ○Non-essential ⊖Omitted

Curriculum Framework

Understanding Manufacturing

Task Number 39

Define *manufacturing*.

Definition

Definition should include the following information from the North American Industry Classification System (NAICS):

- The manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products.
- Establishments in the manufacturing sector are often described as plants, factories, or mills and characteristically use power-driven machines and materials-handling equipment. However, establishments that transform materials or substances into new products by hand or in the worker's home and those engaged in selling to the general public products made on the same premises from which they are sold, such as bakeries, candy stores, and custom tailors, may also be included in this sector.
- Manufacturing establishments may process materials or may contract with other establishments to process their materials for them. Both types of establishments are included in manufacturing.

Teacher Resource: Bureau of Labor Statistics' Industries-at-a-Glance: Manufacturing NAICS 31-33

Definition should also include the concept that information technology (IT) is interwoven throughout manufacturing processes.

Process/Skill Questions

- What is manufacturing?
- What are careers in the manufacturing industry?
- Why is manufacturing important to the economy?
- Where are manufacturing jobs most likely to exist?

- What are the benefits of successful manufacturing?
- How is manufacturing within a candy store different than manufacturing at a mill?
- Why is IT important to the manufacturing sector?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 40

Describe secondary manufacturing processes.

Definition

Description should include the concept that most manufacturing operations employ a combination of these types of processes.

Description should also include the four types of manufacturing systems:

- Custom
- Intermittent
- Continuous
- Flexible

Teacher Resources: Differences Between Manufacturing Systems

Process/Skill Questions

- What type of manufacturing processes do major automobile makers use?
- What are examples of custom-made products?
- What does continuous manufacturing mean? What might be made using that type of production?
- When would each type of manufacturing be used?

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19. Manufacturing Technologies

Task Number 41

Identify the subsectors within manufacturing.

Definition

Identification may include

- Food Manufacturing: NAICS 311
- Beverage and Tobacco Product Manufacturing: NAICS 312
- Textile Mills: NAICS 313
- Textile Product Mills: NAICS 314
- Apparel Manufacturing: NAICS 315
- Leather and Allied Product Manufacturing: NAICS 316
- Wood Product Manufacturing: NAICS 321
- Paper Manufacturing: NAICS 322
- Printing and Related Support Activities: NAICS 323
- Petroleum and Coal Products Manufacturing: NAICS 324
- Chemical Manufacturing: NAICS 325
- Plastics and Rubber Products Manufacturing: NAICS 326
- Nonmetallic Mineral Product Manufacturing: NAICS 327
- Primary Metal Manufacturing: NAICS 331
- Fabricated Metal Product Manufacturing: NAICS 332
- Machinery Manufacturing: NAICS 333
- Computer and Electronic Product Manufacturing: NAICS 334
- Electrical Equipment, Appliance, and Component Manufacturing: NAICS 335
- Transportation Equipment Manufacturing: NAICS 336
- Furniture and Related Product Manufacturing: NAICS 337
- Miscellaneous Manufacturing: NAICS 339

Source: https://www.bls.gov/home.htm

Process/Skill Questions

- What manufacturing industries are located in your geographic area?
- What types of jobs might be available in a manufacturing industry?
- What jobs in a company might be directly related to the production of products?
- Who are the people in your area that work in manufacturing?
- How might your geographical area benefit from manufacturing?

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19. Manufacturing Technologies

Task Number 42

Compare various types of manufacturing business ownership and organization.

Definition

Comparison should examine similarities and differences in the characteristics of different types of business ownership and organization to include

- sole proprietorship
- partnership
- corporation
- franchise
- limited liability company (LLC)
- limited partnership
- joint venture
- S-corporation
- nonprofit corporation
- quasi-public corporation
- cooperative

and discussing the advantages and disadvantages of each.

Comparison should also include the concept that ownership may be corporeal (title to a material/tangible object) or incorporeal (title to an intangible object, such as a copyright).

Process/Skill Questions

- What is a sole proprietorship?
- What is a partnership?
- What is a corporation?
- What are some advantages and disadvantages of each?
- What examples of business ownership are in your area?

ITEEA National Standards

19. Manufacturing Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

Task Number 43

Explain the universal systems model (i.e., input, process, and output).

Definition

Explanation should include

- inputs (i.e., resources)
  - people
  - materials
  - information
  - tools and machines
  - energy
  - capital
  - time
- process (i.e., the way the input is changed to arrive at the output)
- output (i.e., product or end result).

Process/Skill Questions

- How do input, process, and output make up a system?
- What are examples of the systems model?
- What are the strengths and weaknesses of the universal-systems model?
- What are the implications of a failed-systems model in manufacturing?
- How can a system be improved when all parts are functioning properly?

ITEEA National Standards

1. The Characteristics and Scope of Technology

2. The Core Concepts of Technology

Understanding Production Processes

Task Number 44

Explain the product-development process.

Definition

Explanation should include the concept that the product-development process involves a system of defined steps related to ideation, concept testing, business analytics and market analysis/testing, and commercialization. Explanation should also include phases in

- concept development (including establishing need/viability of product)
- detailed design (including research and development)
- production
- field support.

Process/Skill Questions

- Why would someone purchase your product?
- How do you determine the best design for your product?

ITEEA National Standards

19. Manufacturing Technologies

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Engineering

Task Number 45

Distinguish among materials used in the manufacturing process.

Definition

Distinction should include various types of

- woods
- metals
- polymers
- glasses
- ceramics
- fibers
- composites
- nanotechnology

and the origin of each.

Process/Skill Questions

- What are some materials used to make things?
- Where do these materials come from?
- What materials used in manufacturing can you identify in your immediate surroundings?
- What products would be made using wood?
- What products would be made using metal?
- Why is material choice important in the design process?

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 46

Describe the engineering design process.

Definition

Description should include the concept that the engineering design process is a systematic, creative process for solving problems concerning real objects, products, systems, and environments. The engineering design process includes the following steps:

1. Identify the need or opportunity for an engineering solution.
2. Define an engineering design problem.
3. Identify the requirement and constraints of the design problem, including cybersecurity considerations.
4. Research potential solutions to the design problem.
5. Generate (brainstorm) multiple solutions to the design problem.
6. Sketch the multiple solutions to the design problem.
7. Evaluate the requirements and constraints of each solution to the design problem, including cybersecurity considerations.

8. Justify an optimal solution to the design problem, taking into account cybersecurity considerations.
9. Create a model or prototype for the chosen solution to the design problem, using appropriate materials and processes.
10. Determine the objectives for an engineering test of the solution to the design problem, taking into account cybersecurity considerations.
11. Test the solution to the design problem, using mathematical, conceptual, and/or physical modeling, simulating, and optimizing; take into account cybersecurity considerations.
12. Evaluate the test results, including cybersecurity considerations.
13. Formulate an alternate solution to the design problem, if needed.
14. Test the alternate solution, if needed.
15. Present the final project report.
16. Document the final project report.

Process/Skill Questions

- How can design problems be identified?
- What are the types of problems that concern product developers?
- Why is it important to identify criteria and constraints?
- What techniques are used to refine a design?
- How can a design be evaluated?
- What is quality control?
- Why should final solutions be re-evaluated? How is this done?
- What are the basic requirements of design?
- What are ergonomics?
- What are functional requirements?
- How important is it to document every phase of the design process?
- How can a sketch created in the beginning of the engineering design process be important in an eventual product redesign?

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Engineering Design

Task Number 47

Explain the effect of automation on the manufacturing processes.

Definition

Explanation should include

- employment/labor costs
- automation and outsourcing (and the pros and cons of each)
- robotics (production increase vs. cost of labor)
- political and social ramifications that accompany automation.

Teacher Resource:
Automation Article

Process/Skill Questions

- What are some examples of automated systems?
- What careers are associated with automated systems?
- What jobs have been eliminated over the past 50 years by automation?
- How can automation benefit the workforce when it eliminates some jobs while creating others?
- Automation sometimes is considered a negative thing for employment. Why?

ITEEA National Standards

19. Manufacturing Technologies

6. The Role of Society in the Development and Use of Technology

7. The Influence of Technology on History

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 48

Use the engineering design process to plan production.

Definition

Use should include

- working drawings
- bill of materials
- operation sheet, flow-process chart, operation-process chart, Gantt chart

- plan layout
- preparation for expansion and growth in design.

Process/Skill Questions

- What is the difference between orthographic and isometric drawings?
- What is included in the bill of materials?
- How do the flow-process chart, operation-process chart, and operation sheet interrelate?
- How can modeling and simulation give aid to production planning?
- Why is documentation important when beginning to plan production?

ITEEA National Standards

19. Manufacturing Technologies

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 49

Differentiate between primary and secondary manufacturing processes.

Definition

Differentiation should include the characteristics of primary and secondary manufacturing processes:

- Primary manufacturing processes
    - Obtaining raw materials
    - Producing useable industrial materials
- Secondary manufacturing processes
    - Casting and molding
    - Forming
    - Separating
    - Conditioning
    - Assembling
    - Finishing

Differentiation should also include the concept that, often, the manufacture of a product will utilize several of these processes, and that automation is involved throughout these processes.

Process/Skill Questions

- What is the difference between a primary and secondary process?
- What are examples of combining processes?
- What are examples of forming processes?
- What are examples of separating processes?
- What are examples of conditioning processes?
- What are examples of assembling processes?
- What are examples of finishing processes?
- Why is the orders of processes important?

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19. Manufacturing Technologies

TSA Competitive Events

Technology Bowl

Task Number 50

Evaluate the production process.

Definition

Evaluation should include

- description of how the individual tasks affect the production line as a whole
- identification of bottlenecks in the process
- inspection of production output
- suggestions for improving the line process.

Process/Skill Questions

- How well did an individual task fit into the production of the product? What caused difficulty?
- What happened in the production line that could be improved?
- How can evaluation of one production process benefit future designs?

- What is meant by the concept that “production processes are an evolution of manufacturing"?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Exploring Automated Tools Related to Manufacturing

Task Number 51

Describe the use of computer-aided design (CAD) in manufacturing.

Definition

Description includes

- use of various CAD software for the creation, modification, and optimization of the design
- relationship among CAD, computer-aided engineering (CAE), and computer-aided manufacturing (CAM).

Process/Skill Questions

- What are the differences between CAD, CAE, and CAM?
- What is CAD?
- What is CAE?
- What is CAM?
- How can CAD, CAE, and CAM be used in automation?

ITEEA National Standards

19. Manufacturing Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Computer-Aided Design (CAD), Engineering

Task Number 52

Produce a design for three-dimensional (3D) printing.

Definition

Production may include

- rapid prototyping
- 3D CAD model.

Process/Skill Questions

- What is scale?
- What is rapid prototyping?
- How can a CAD drawing be used in manufacturing?
- What is the connection between CAD and CAM with regard to 3D printing?
- What is an extruder on a 3D printer?
- How are 3D coordinates used to build a 3D print?

ITEEA National Standards

19. Manufacturing Technologies

8. The Attributes of Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Engineering

Task Number 53

Explain CAM.

Definition

Explanation should include the use of numerical control (NC) software that drive computer numerical control (CNC) machine tools for manufacturing parts.

Process/Skill Questions

- What are some examples of CNC machines, e.g., routers?
- What are the benefits of using CAM systems?
- What is CNC programming?
- What are Cartesian coordinates and how are they used in CAM?
- What is a tool path?
- How is Boolean logic used in CAM?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 54

Explain a programmable logic controller (PLC).

Definition

Explanation may include

- ladder logic
- structured text
- function block diagram (FBD)
- sequential function chart (SFC)

- instruction list (IL).

Teacher Resource:
What is a Programmable Logic Controller?

Process/Skill Questions

- What are common inputs and outputs of a PLC?
- How is ladder logic incorporated in a PLC?
- How does structured text compare to a function block diagram?

ITEEA National Standards

19. Manufacturing Technologies

Task Number 55

Explain a microcontroller.

Definition

Explanation should include

- defining a microcontroller as a device with a computer on a chip used to control the action of systems.
- defining a controller as the brain of the robot or the center of a robotic system that coordinates all movements of the mechanical system
- outlining the functions performed by a microcontroller
    - controller receives input from various sensors, a radio-controlled (RC) transmitter and the computer processes that input with a program stored in the controller memory
    - computer responds by activating pneumatics, motors, sensors, or other actuators
- comparing features of different types of controllers such as a peripheral interface controller (PIC) and a programmable logic controller (PLC)
- choosing the right microcontroller for a robotic project
- providing examples of microcontrollers used in industry applications.

Teacher Resources:
What is a Microprocessor?
What is a Microcontroller?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Coding

Task Number 56

Differentiate between open and closed loops in control systems.

Definition

Differentiation should include

- defining open-loop system (i.e., a system without a feedback mechanism) (e.g., washing machine, irrigation sprinkler system, robot driving from joystick input)
- defining closed-loop system (i.e., a system with a feedback mechanism) (e.g., aquarium pump, hot water heating system, computer mouse, joystick on a video game, robot driving toward a light)
- describing why one system would be preferred over the other.

Process/Skill Questions

- What is an input?
- What is a process?
- What is an output?
- How can feedback change a system?
- What are the differences between open-loop systems and closed-loop systems?
- What are some examples of open-loop and closed-loop systems?
- What are the strengths of a closed-loop system?
- How are open-loop systems used in everyday life?

ITEEA National Standards

19. Manufacturing Technologies

2. The Core Concepts of Technology

Task Number 57

Develop a control system, based on given needs and constraints.

Definition

Development should include

- open control systems
- closed control systems (use of sensors)
- security considerations.

Development may also include programming a robot or a microcontroller.

Teacher Resource:
Carnegie Mellon Robotics Academy

Process/Skill Questions

- What is a controlled system and how does it operate?
- What does a system do and how can we design a manner of controlling it?
- What is a sensor?
- What are the different types of consumer sensors?
- What is the importance of using control systems?
- What is the difference between an open and a closed control system?

ITEEA National Standards

17. Information and Communication Technologies

2. The Core Concepts of Technology

9. Engineering Design

Coding

Computer Integrated Manufacturing (CIM)

Exploring the Evolution of Manufacturing

Task Number 58

Outline the history of manufacturing, with an emphasis on the development of manufacturing in the United States.

Definition

Outline should include a summary of the critical stages that manufacturing has undergone, as well as the factors influencing the development of manufacturing, including

- materials
- energy sources
- transportation
- communication
- design
- process improvement
- employment
- market research
- suppliers
- capital
- commission
- quality control.

Process/Skill Questions

- How did the invention of the steam engine affect manufacturing?
- What were the two most important improvements made by Watt's steam engine?
- What century is associated with the American system of manufacturing?
- In what way did the invention of interchangeable parts alter manufacturing? Line production? Automation?
- What economic class of people did manufacturing jobs help build in the United States during the 19th century?

- What are the critical stages of United States manufacturing?
- How have natural resources contributed to the development of United States manufacturing?
- What years are considered the peak (so far) of United States manufacturing?
- How is manufacturing developing further through the advent of additive manufacturing, augmented reality, and nanotechnology?

ITEEA National Standards

19. Manufacturing Technologies

7. The Influence of Technology on History

TSA Competitive Events

Technology Bowl

Task Number 59

Describe current and emerging trends in manufacturing.

Definition

Description should define current and emerging trends as those that are

- new practices, behaviors, or styles accepted as desirable by consumers
- driven by technological advances and evolving and changing frequently
- often determined by demographic research, the results of which are often completely subjective
- a result of qualitative and quantitative data analysis
- perpetuated when companies see them as essential to successful manufacturing.

Process/Skill Questions

- How can understanding an industry's past help understand current and emerging trends?
- What recent communication developments might lead to new trends in manufacturing?
- How might the push toward cleaner energy influence manufacturing in the future?
- How was manufacturing in the U.S. in the 19th century similar to, and different from, manufacturing in the 21st century?
- What country’s manufacturing workers are considered the most productive in the world? Why?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Understanding Cybersecurity

Task Number 60

Describe cybersecurity.

Definition

Description should state that cybersecurity is the protection of information and data —which includes information systems (e.g., networks, hardware, software), the human element, and physical elements—from risks associated with threats, attacks, hazards, or physical damage.

Teacher Resource:
Virginia Space Grant Consortium's Breaking the Code on a Career in Cybersecurity (YouTube playlist)

Process/Skill Questions

- How could cybersecurity impact your job in the future?
- How might you impact others with a career in cybersecurity?

TSA Competitive Events

Coding

Task Number 61

Describe the critical factors of information security.

Definition

Description should include

- explaining that the confidentiality/integrity/availability (CIA) triad model provides the baseline standard of evaluating and implementing information security measures on any system
- stating that each component in the CIA triad has designated goals that provide distinct requirements, and that each goal provides an essential component of information security measures
- identifying the following goals within the CIA triad and defining the terms as they apply to cybersecurity:
    - *Confidentiality*: The goal ensures that data are only accessed by authorized person(s) through security measures such as user names and passwords and access control lists (ACL).
    - *Integrity*: The goal ensures the data are trusted. This means data must be guarded against unauthorized changes. Methods of ensuring integrity include data permissions and encryption.
    - *Availability*: The goal is to provide solutions to ensure that systems can be accessed when requested. This includes providing deploying system protections and proper hardware maintenance and system patching.
    - Additional components should include the following:
        - *Authentication*: A process in which credentials are provided to verify the identity of an entity (e.g., user, system).
        - *Nonrepudiation*: A cryptologic technique that provides the proof of the integrity and origin of data.

Description should also include manufacturing system-specific elements:

- Priority of the CIA triad based on specific critical infrastructure sectors
- Emphasis on Availability and Integrity in manufacturing systems

Process/Skill Questions

- With regard to cybersecurity, CIA stands for what?
- What does availability mean with regard to cybersecurity?
- Why is data integrity important?
- Why is there is a trade-off between confidentiality, integrity, and availability?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Coding

Task Number 62

Explain cybersecurity services as they relate to cyber incident prevention.

Definition

Explanation should include the services included to protect against the following elements of the cyber kill chain:

- Unauthorized access
- Exploitation
- Privilege escalation
- System compromise
- Service disruption and data exfiltration

Explanation should also involve the concept that cybersecurity services provide the tools, methods, and procedures that a business can use to protect its system from unauthorized access to, or the copying, transfer, or retrieval of data. Services can range from storing backups at remote sites to fire-suppression systems, along with network monitoring of vulnerable software against intruders.

Process/Skill Questions

- How might a company know that its system has been compromised?

ITEEA National Standards

17. Information and Communication Technologies

TSA Competitive Events

Coding

Task Number 63

Distinguish among types of ethical concerns in cybersecurity.

Definition

Distinction should include

- describing ethical and unethical behaviors
- understanding that organizations must balance reasonable security with reasonable access.

Process/Skill Questions

- What behaviors would be considered unethical cyber behaviors?
- What are white hats? Where do the white hats draw the line?

ITEEA National Standards

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Coding

Task Number 64

Identify laws/regulations applicable to cybersecurity.

Definition

Identification should include, but not be limited to

- federal laws, regulations, policies/and or standards
    - Privacy Act of 1974
    - Electronic Communications Privacy Act of 1986 (ECPA)
    - Counterfeit Access Device and Computer Fraud and Abuse Act of 1984
    - Cyber Security Information Sharing Act of 2015 (CISA)
    - Health Insurance Portability and Accountability Act (HIPAA)

    - Telecommunications Act of 1996
    - Gramm-Leach-Bliley Act
    - Family Educational Rights and Privacy Act (FERPA)
    - Sarbanes-Oxley Act of 2002 (SOX)
- international laws and standards
    - European Union [EU] directive on security of network and information systems (NIS Directive)
    - North American Electric Reliability Corporation Critical Infrastructure Protection (NERC CIP).
- manufacturing sector-specific standards (e.g., Chemical Facility Anti-Terrorism Standards (CFAT])

Process/Skill Questions

- How do cybersecurity laws relate to the CIA triad?
- How do cybersecurity laws impact business?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Coding

Task Number 65

Differentiate between ethics and laws.

Definition

Differentiation should include the following:

- Ethics are the moral principles that guide a person's conduct.
- Laws are the set of accepted rules and regulations created by appropriate authorities, such as national, state, or local governments. Legal issues can include significant privacy and data security concerns, which can open up an organization to potential legal and liability risks.

Differentiation should also include examples of situations which have legal or ethical impact in the manufacturing sector (e.g., the impact of posting manufacturing facility pictures online without permission).

Process/Skill Questions

- How does a company determine the trustworthiness of potential hires?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Technology Bowl

Task Number 66

Identify concepts related to copyright, public domain, copy protection, intellectual property, and licensing agreements.

Definition

Identification should include, but not be limited to, software, media (e.g., music, pictures), logo requirements, and

- a list of terms
- examples of each concept
- laws covering the protection of published information
- legal and ethical issues arising from the infringement of copyright laws and licensing agreements.

Identification should also include an examination of the rights and protections for owners of intellectual property against

- international espionage
- industrial espionage
- insider threats.

Process/Skill Questions

- Is it true that it isn't considered stealing if the person didn't know it was pirated software? Explain.
- What pictures on the Internet are free to use? Explain.
- What are some examples of intellectual property?

ITEEA National Standards

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Coding

Exploring Vulnerabilities, Risks, and Threats in Manufacturing Systems

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Task Number 67

Define *risk*.

Definition

Definition should state that *risk* is the likelihood that a vulnerability will occur and that a loss occurs when that vulnerability is exploited.

Definition should distinguish between *risk*, *threat*, and *vulnerability*.

Teacher resources:
https://www.threatanalysis.com/2010/05/03/threat-vulnerability-risk-commonly-mixed-up-terms/
http://cyberphysicalsystems.org/
https://www.nist.gov/el/cyber-physical-systems

Process/Skill Questions

- What is a cyber-physical system?

- Viewing a cyber-physical system's concept map, how can one determine where possible risks, threats and vulnerabilities may occur?

ITEEA National Standards

19. Manufacturing Technologies

Task Number 68

Analyze risks affecting the 16 critical infrastructure sectors.

Definition

Analysis should include

- defining *critical infrastructure* sectors as including assets critical to the functioning of a society and economy
- identifying possible vs. probable loss within the critical infrastructure sectors to help assess financial impact within the infrastructure
- evolving threats, including, but not limited to
    - cyber threats
    - acts of terrorism
    - pandemics
    - extreme weather
    - accidents or technical failures
    - societal unrest
- relating evolving threats to manufacturing as one of the identified 16 critical infrastructure sectors, such as
    - loss of intellectual property
    - machine-to-machine communication disruption
    - disruption to production processes
    - disruption of Industrial Internet of Things (IIoT)
    - disruption resulting in threats to human health and safety.

For further information see Presidential Policy Directive (PPD)-21 Critical Infrastructure Security and Resilience (2013) and Executive Order (EO) 13636 Improving Critical Infrastructure Cybersecurity (Issued Dec 2016).

Process/Skill Questions

- How can one develop a threat protection guide? How can one visualize the type of threats, and prioritize those threats, within the guide?
- What are some proactive prevention measures to defend against evolving threats?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Task Number 69

Describe the characteristics of vulnerabilities.

Definition

Description should include

- defining the term vulnerability as a weakness that allows an attacker to reduce a system's information assurance
- understanding that a large number of vulnerabilities historically have been through flaws in software
- describing elements that make a system vulnerable, such as
    - system susceptibility or flaw
    - attacker access to the flaw
    - attacker capability to exploit the flaw
- explaining the effect of a vulnerability on a system (i.e., compromised confidentiality, integrity, or availability of resources)
- discussing flaws in software that can lead to vulnerabilities, such as
    - buffer overflow or broken authentication and session management
    - injection vulnerabilities
    - input validation
    - privilege confusion
    - session handling
    - obsolete versions
- evaluating vulnerabilities as they relate to
    - physical facilities and environment of the system or personnel working with the system
    - operational procedures, including security measures
    - business operations
    - hardware
    - software
    - communication equipment and network (individually or in combination).

Process/Skill Questions

- What are the top five cybersecurity vulnerabilities?

- How have historical flaws in software applications been improved to cut down on vulnerability and threat?
- What cryptographic problems could be seen as a vulnerability?

ITEEA National Standards

17. Information and Communication Technologies

Task Number 70

Describe the cybersecurity threats to a manufacturing system.

Definition

Description should demonstrate an understanding that

- an action might exploit a vulnerability to breach security and cause potential harm
- threats come from many sources (e.g., insider threats, network threats, physical threats such as fire or floods, threats stemming from software systems or user actions).

Teacher Resource: Open Web Application Security Project

Process/Skill Questions

- What is considered the most costly cybersecurity threat to manufacturing systems?
- What is the purpose of the Open Web Application Security Project (OWASP)?
- What are the top 10 projects in OWASP? How do these projects benefit the manufacturing systems?
- What does the Cybersecurity Trends Report for the current year list as the top threats?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Coding

Task Number 71

Describe the cyberattack surface of the standard equipment that connects the manufacturing system and the enterprise's integrated IT system.

Definition

Description should include equipment that will connect the manufacturing system, such as

- network
- servers
- firewalls
- routers
- operating system/software managing the connection.

Description should also include consideration of attack avenues such as

- phishing
- pharming
- social engineering.

Process/Skill Questions

- How can the manufacturing sector identify cyber threats to watch for this year and beyond?
- What are subdivisions/categories of an attack surface?
- What are examples of attack vectors?

ITEEA National Standards

17. Information and Communication Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 72

Describe the cyberattack surface of manufacturing systems.

Definition

Description should include the identification of the attack surface as being the sum of the points at which an unauthorized user can attempt to gain access to the system to extract information or disrupt processes.

Description should also include

- network architecture segmentation
- knowledge that companies have differing levels of vulnerability due to their integration of technology.

Process/Skill Questions

- What are passive attacks?
- What are active attacks?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 73

Describe the cyberattack surface of the manufacturing supply chain.

Definition

Description should include

- outside materials
- supplies
- equipment.

Process/Skill Questions

- What would an attack surface analysis entail?
- What proactive models can be used to recognize or prevent surface attacks?
- What is the Internet Security Threat Report (ISTR)?
- How can the ISTR be useful in identifying and preventing attacks on supplies, equipment, and outside materials?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Managing Risks in Manufacturing

Task Number 74

Explain why the manufacturing sector needs to manage cyber risk.

Definition

Explanation should include the following:

- Unmanaged risk can cause loss in product, time/productivity, reputation, and/or profit/revenue.
- The protection of the product may also ensure public/consumer safety.
- Every organization is vulnerable to common and unique types of threats.
- Organizations must identify vulnerable areas, along with the potential for actual threats, so they can plan operations to reduce the effect of those threats.

- Because all threats cannot be completely eliminated, organizations must address responses to threats as well as contingency plans for continuous manufacturing operations.

Process/Skill Questions

- How should an employer protect the company against malicious industrial espionage, disgruntled employees, and high-end hackers?
- What type of prevention method can ward off cybercrime in your organization?
- Why do you need to have a list of cybersecurity roles and responsibilities for the organization's workforce and managers?
- What makes the manufacturing sector unique in terms of cybersecurity?
- What would happen if an attacker would access the industrial control systems (ICS) in a manufacturing enterprise?
- What is the impact of a cyber incident on the physical environment in a manufacturing enterprise?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 75

Explain the importance of creating and enforcing plans, policies, and procedures to manage risk.

Definition

Explanation should include the difference between a plan, a policy, and a procedure and should address

- employee policies (e.g., acceptable use policies [AUPs])
- incident (i.e., breach) response

- legal/oversight requirements.

Process/Skill Questions

- When a school AUP has a guideline not included in state or federal statutes, do you have to comply with the school policy?
- Does it matter whether you have signed the school AUP in terms of your accountability for violating the policy?
- How should an employer go about informing workers of changes to the AUP?
- What are ICS and why is important to secure them?
- How are ICS and IT Systems Security different?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 76

Identify the concepts of cybersecurity risk management.

Definition

Identification should include

- defining risk management as the process of identifying possible vulnerabilities and quantifying potential risk as it pertains to systems
- addressing risk management strategies, including but not limited to
    - r*isk mitigation*: reducing the likelihood of the risk
    - *risk transfer*: transferring the risk to another company, such as an insurance firm
    - *risk avoidance*: avoiding the possibility of the risk (e.g., not using a specific software program would avoid any known risks of that program)
    - *risk acceptance*: understanding and accepting the risks associated with use of a system or feature.

Process/Skill Questions

- How can periodic risk assessments identify physical security threats and vulnerabilities that may affect cybersecurity?
- Why do you need to identify published cybersecurity risk management standards, such as those issued by the National Institute of Standards and Technology (NIST) or the International Organization for Standardization (ISO)?
- What are the steps of the basic process for developing a security program?
- What are the benefits of developing and deploying a security program?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Task Number 77

Identify prevention of and protection systems against cyber threats in manufacturing.

Definition

Identification should include the concept that

- security awareness related to social engineering threats is a critical part of ICS incident prevention
- preventions and protections against cyberattacks change as the targets, vulnerabilities, and threats change
- each vulnerability will have its own unique set of preventions and protections, and should include, but not be limited to
    - network protection as the initial line of defense (e.g., authentication, virus protection software, anti-spyware, anti-adware, firewalls, intrusion prevention)
    - operating systems and applications as critical to reducing vulnerabilities and identification of systems maintenance measures that assist in system protection (e.g., system updates and audits)
    - secure coding practices in database information and programming as critical to preventing injection vulnerabilities, in which an application sends untrusted data to an interpreter (e.g., Attackers use exploit injection flaws to steal data and compromise the target system. Protection measures should be evaluated in the system design and programming phase. Addressing this concept in design and development will prevent flaws in production.)
    - user training to make users aware of potential threats resulting from their actions.

Process/Skill Questions

- Why might a company restrict user access to the network resources necessary for their business functions?
- What are examples of practices and controls regarding the protection of networks and information?
- What is social engineering and how can it be used to compromise otherwise secure systems?
- What are some examples of possible threat sources?
- What are the categories of potential vulnerabilities and predisposing conditions commonly found within ICS systems?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Task Number 78

Identify prevention of and protections against threats throughout each stage of the manufacturing process.

Definition

Identification should include

- designing the manufacturing process with security/risk management in mind
- securing the supply chain
- implementing industrial control systems security.

Process/Skill Questions

- What is meant by securing the supply chain?
- What could happen if the supply chain is not secured?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Task Number 79

Explain the importance of physical security controls.

Definition

Explanation may include physical vulnerabilities and predisposing conditions and the following:

- Tamper protection alerts
- Lighting
- Signs
- Fencing/gate/cage
- Security guards
- Alarms
- Safes
- Secure cabinets/enclosures
- Protected distribution/Protected cabling
- Airgap
- Mantrap
- Faraday cage
- Lock types
- Biometrics
- Barricades/bollards
- Tokens/cards
- Environmental controls
    - heating, ventilation, and air conditioning (HVAC) systems
    - Hot and cold aisles
    - Fire suppression
- Cable locks
- Screen filters
- Cameras
- Motion detection
- Logs
- Infrared detection
- Key management

Process/Skill Questions

- What logs can be evaluated for security issues?

- Where would one locate evidence of an access violation?
- To gain access to the environment, which security controls should be used?
- What is the purpose of a Faraday cage?
- What are the security implications of automated environmental controls?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Task Number 80

Describe appropriate incident response procedures.

Definition

Description should include the following:

- Incident symptoms, classification of incidents
- Incident response plan
    - Documented incident types/category definitions
    - Roles and responsibilities
    - Reporting requirements/escalation both internal and external (e.g., Occupational Safety and Health Administration [OSHA], Environmental Protection Agency [EPA], Food and Drug Administration [FDA], product recall requirements)
    - Cyber-incident response teams
    - Exercise/drill/simulation
- Incident response process
    - Preparation
    - Detection and analysis
    - Containment
    - Eradication
    - Recovery
    - Lessons learned

Process/Skill Questions

- What is the difference between an incident response plan and an incident response process?
- Why is it important to have incident response exercises?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

Practicing Safety in Manufacturing

Task Number 81

Use required personal protective equipment (PPE).

Definition

Use should include

- identifying potential hazards
- identifying safety data sheets (SDS)
- describing equipment that protects against each hazard
- wearing PPE when performing hazardous tasks.

Process/Skill Questions

- What are the names and purposes of five pieces of PPE?
- When would it be necessary to wear PPE?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Engineering Design

Task Number 82

Implement a safety plan.

Definition

Implementation should include

- taking a safety proficiency test with a 100 percent pass rate
- adhering to basic safety rules
- pre-job briefing.

Process/Skill Questions

- Why do you have to pass the safety test with a score of 100 percent?
- What could happen if you don't follow every safety rule?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 83

Maintain safe working practices around production equipment.

Definition

Maintenance should include

- identifying potential hazards of each piece of equipment
- demonstrating safe work habits with each type of equipment
- adhering to OSHA standards.

Process/Skill Questions

- What are the risks of unsafe behavior around production equipment?
- How would safety rules help prevent these risks?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 84

Operate lab equipment according to instructor guidelines.

Definition

Operation should include

- following posted safety rules for each piece of equipment
- using guards as required
- passing a proficiency demonstration with the instructor.

Process/Skill Questions

- How are the posted safety rules for any two pieces of equipment similar and different?
- Why are guards necessary?
- How would you know if you are using a piece of equipment improperly?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Establishing a Manufacturing Enterprise

Task Number 85

Identify current laws and regulations affecting the establishment and operation of manufacturing businesses.

Definition

Identification should include resources for researching business laws, codes, and regulations. These may include

- business licensure
- professional licensure
- zoning codes
- city ordinances
- OSHA requirements
- insurance requirements
- labor laws
- Americans with Disabilities Act (ADA) requirements
- federal, state, and local tax codes
- interstate vs. intrastate law.

Process/Skill Questions

- What does it mean to be an equal opportunity employer?
- What are the legal and regulatory consequences of not keeping and maintaining accurate records?

ITEEA National Standards

19. Manufacturing Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

TSA Competitive Events

Task Number 86

Plan a product.

Definition

Plan should include

- use of product
- value of product
- industry sector that product would be classified in
- supplies required to make product
- process and/or equipment required to make product
- cost to make product
- time to make product.

Plan also should include consideration of requirements and constraints as determined by the instructor.

Organize a business plan for the student enterprise.

Organization should include:

- a summary: company identity (name and logo), product specifics
- a mission: what is the problem you are going to solve? Why?
- product description: structure and function, user perspective
- market study: customer profile, competitors, trends
- operations design and planning
- sustainability.

Process/Skill Questions

- Why is product planning necessary?
- What is the marginal cost of your product?
- What do people like and dislike about your product?
- How does your new product fill a niche?
- What activities are performed during the business enterprise design?

ITEEA National Standards

19. Manufacturing Technologies

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Technology Bowl

Task Number 87

Identify a business team for product development.

Definition

Identification should include roles and responsibilities of each team member to encompass

- the design process
- the manufacturing process
- product packaging and marketing.

Identification should also include

- establishing a business hierarchy
- determining a security officer
- establishing a budget

for your production team.

Process/Skill Questions

- What are the primary responsibilities of management?

ITEEA National Standards

19. Manufacturing Technologies

4. The Cultural, Social, Economic, and Political Effects of Technology

6. The Role of Society in the Development and Use of Technology

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 88

Design a product using CAD.

Definition

Design should include

- concept sketches
- prototype ideas
- size and weight constraints of product evaluated
- selection of materials
- CAD product based on design decisions.

Process/Skill Questions

- What type of design is CAD?
- What is the tool that allows you to create virtual prototypes?
- What tool allows you to visualize and share designs?
- What are the benefits of using CAD?

ITEEA National Standards

11. Apply the Design Processes

12. Use and Maintain Technological Products and Systems

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Computer-Aided Design (CAD), Engineering

Task Number 89

Design the process for product creation using automation.

Definition

Design process for product creation should include

- listing technologies available for product creation
- evaluating each automated process to compare effectiveness for product
- listing the steps to create the product using the chosen automation method
- identifying the supplies to make the product.

Process/Skill Questions

- What are some examples of automated systems?

ITEEA National Standards

19. Manufacturing Technologies

8. The Attributes of Design

9. Engineering Design

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 90

Identify trade secrets and proprietary information of a manufacturing enterprise.

Definition

Identification should include

- product design
- production process
- competitive advantage.

Process/Skill Questions

- What is meant by “trade secrets”?
- What is competitive advantage?

ITEEA National Standards

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Technology Bowl

Task Number 91

Identify the prevention of and protections against cyber threats for a manufacturing enterprise.

Definition

Identification should include

- securing documents
- securing access to manufacturing processes
- securing the network connected to the manufacturing equipment
- developing a risk management plan for your manufacturing enterprise.

Process/Skill Questions

- What are the basic steps an organization should take to safeguard against cyber threats for a manufacturing enterprise?
- How can a manufacturing organization prevent cyber threats?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 92

Secure the product using cybersecurity best practices.

Definition

Security should include

- identifying vulnerabilities and risks
- testing access points to the product
- using input/output validations
- applying CIA triad as appropriate (e.g., authentication/encryption)
- identifying methods of remediation.

Process/Skill Questions

- How are the cyber security principles applicable to ICS, Control Systems and IoT?

ITEEA National Standards

17. Information and Communication Technologies

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Task Number 93

Create product.

Definition

Creation should include acquiring the supplies necessary and using the manufacturing process to make the product.

Process/Skill Questions

- What materials are the most appropriate for your product?
- What processes can you use to manufacture your product?

ITEEA National Standards

12. Use and Maintain Technological Products and Systems

19. Manufacturing Technologies

TSA Competitive Events

Computer Integrated Manufacturing (CIM)

Engineering Design

SOL Correlation by Task

39	Define *manufacturing*.	English: 10.3, 10.5, 10.8, 11.3, 11.5, 11.8, 12.3, 12.5, 12.8 History and Social Science: VUS.6, VUS.8, VUS.10, WHII.8
40	Describe secondary manufacturing processes.	English: 10.5, 11.5, 12.5
41	Identify the subsectors within manufacturing.	History and Social Science: VUS.6, VUS.8, VUS.10, WHII.10
42	Compare various types of manufacturing business ownership and organization.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.9, GOVT.15, VUS.8, VUS.10, WHII.14
43	Explain the universal systems model (i.e., input, process, and output).	English: 10.5, 11.5, 12.5

		History and Social Science: GOVT.1, GOVT.12, GOVT.13, GOVT.14, GOVT.15, VUS.1, VUS.8, VUS.11, WHII.1, WHII.4, WHII.6, WHII.8, WHII.13, WHII.14 Mathematics: A.7
44	Explain the product-development process.	English: 10.5, 11.5, 12.5
45	Distinguish among materials used in the manufacturing process.	
46	Describe the engineering design process.	English: 10.1, 10.5, 10.6, 10.8, 11.1, 11.5, 11.6, 11.8, 12.1, 12.5, 12.6, 12.8 History and Social Science: GOVT.1, GOVT.6, VUS.13, VUS.14 Mathematics: A.4, A.5, A.7, A.8, A.9, PS.5, PS.1*, PS.2*, PS.4*, PS.8*
47	Explain the effect of automation on the manufacturing processes.	English: 10.5, 11.5, 12.5 Mathematics: A.4, A.5
48	Use the engineering design process to plan production.	
49	Differentiate between primary and secondary manufacturing processes.	English: 10.5, 11.5, 12.5 History and Social Science: WHII.1, WHII.8, WHII.9, WHII.10, WHII.14
50	Evaluate the production process.	English: 10.5, 11.5, 12.5
51	Describe the use of computer-aided design (CAD) in manufacturing.	English: 10.5, 11.5, 12.5 History and Social Science: WHII.14 Mathematics: COM.1
52	Produce a design for three-dimensional (3D) printing.	Mathematics: COM.1
53	Explain CAM.	English: 10.5, 11.5, 12.5 Mathematics: COM.1
54	Explain a programmable logic controller (PLC).	English: 10.5, 11.5, 12.5 Mathematics: COM.1
55	Explain a microcontroller.	English: 10.3, 10.5, 10.6, 10.7, 11.3, 11.5, 11.6, 11.7, 12.3, 12.5, 12.6, 12.7 Mathematics: COM.1, COM.10, COM.11
56	Differentiate between open and closed loops in control systems.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5

57	Develop a control system, based on given needs and constraints.	
58	Outline the history of manufacturing, with an emphasis on the development of manufacturing in the United States.	English: 10.6, 10.7, 11.6, 11.7, 12.6, 12.7 History and Social Science: VUS.1, VUS.3, VUS.6, VUS.8, VUS.11
59	Describe current and emerging trends in manufacturing.	English: 10.5, 11.5, 12.5 History and Social Science: VUS.13
60	Describe cybersecurity.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 History and Social Science: GOVT.1, VUS.13, VUS.14 Mathematics: COM.1
61	Describe the critical factors of information security.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13
62	Explain cybersecurity services as they relate to cyber incident prevention.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13 Mathematics: COM.16, COM.17
63	Distinguish among types of ethical concerns in cybersecurity.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.16, VUS.13
64	Identify laws/regulations applicable to cybersecurity.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 History and Social Science: GOVT.15, VUS.1
65	Differentiate between ethics and laws.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.15, GOVT.16, VUS.1
66	Identify concepts related to copyright, public domain, copy protection, intellectual property, and licensing agreements.	English: 10.5, 11.5, 12.5
67	Define *risk*.	English: 10.3, 11.3, 12.3
68	Analyze risks affecting the 16 critical infrastructure sectors.	English: 10.3, 10.5, 10.8, 11.3, 11.5, 11.8, 12.3, 12.5, 12.8

		History and Social Science: GOVT.1, GOVT.6, VUS.13, VUS.14, WHII.14
69	Describe the characteristics of vulnerabilities.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13 Mathematics: COM.2, COM.3
70	Describe the cybersecurity threats to a manufacturing system.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13
71	Describe the cyberattack surface of the standard equipment that connects the manufacturing system and the enterprise's integrated IT system.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13, VUS.14
72	Describe the cyberattack surface of manufacturing systems.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13
73	Describe the cyberattack surface of the manufacturing supply chain.	English: 10.5, 11.5, 12.5
74	Explain why the manufacturing sector needs to manage cyber risk.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.1, GOVT.6, VUS.13
75	Explain the importance of creating and enforcing plans, policies, and procedures to manage risk.	English: 10.5, 11.5, 12.5
76	Identify the concepts of cybersecurity risk management.	English: 10.3, 10.5, 11.3, 11.5, 12.3, 12.5 Mathematics: COM.1
77	Identify prevention of and protection systems against cyber threats in manufacturing.	History and Social Science: GOVT.1, GOVT.6, VUS.13
78	Identify prevention of and protections against threats throughout each stage of the manufacturing process.	History and Social Science: GOVT.1, GOVT.6, VUS.13
79	Explain the importance of physical security controls.	English: 10.5, 11.5, 12.5
80	Describe appropriate incident response procedures.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.16
81	Use required personal protective equipment (PPE).	English: 10.5, 11.5, 12.5 Science: CH.1

82	Implement a safety plan.	English: 10.5, 11.5, 12.5 Science: CH.1
83	Maintain safe working practices around production equipment.	English: 10.5, 11.5, 12.5 History and Social Science: GOVT.14 Science: CH.1
84	Operate lab equipment according to instructor guidelines.	English: 10.5, 11.5, 12.5 Science: CH.1
85	Identify current laws and regulations affecting the establishment and operation of manufacturing businesses.	English: 10.5, 10.8, 11.5, 11.8, 12.5, 12.8 History and Social Science: GOVT.14
86	Plan a product.	English: 10.1, 10.5, 10.6, 11.1, 11.5, 11.6, 12.1, 12.5, 12.6 Mathematics: A.4, A.5, PS.8*
87	Identify a business team for product development.	English: 10.1, 11.1, 12.1 Mathematics: A.3, A.4, A.5
88	Design a product using CAD.	History and Social Science: WHII.14
89	Design the process for product creation using automation.	English: 10.6, 11.6, 12.6 History and Social Science: GOVT.16
90	Identify trade secrets and proprietary information of a manufacturing enterprise.	
91	Identify the prevention of and protections against cyber threats for a manufacturing enterprise.	History and Social Science: GOVT.1, GOVT.6, VUS.13
92	Secure the product using cybersecurity best practices.	History and Social Science: GOVT.1, GOVT.6, VUS.13
93	Create product.	History and Social Science: VUS.6, VUS.8, VUS.10, WHII.8

Teacher Resources

AFA CyberPatriot is the National Youth Cyber Education Program created by the Air Force Association to inspire K-12 students toward careers in cybersecurity or other science, technology, engineering, and mathematics (STEM) disciplines critical to our nation's future. At the core of the program is the National Youth Cyber Defense Competition, the nation's largest cyber defense competition that puts high school and middle school students in charge of securing virtual networks.

This provides quick access to the links provided in the body of the curriculum framework.

Differences Between Manufacturing Systems

Food Manufacturing: NAICS 311
Beverage and Tobacco Product Manufacturing: NAICS 312
Textile Mills: NAICS 313
Textile Product Mills: NAICS 314
Apparel Manufacturing: NAICS 315
Leather and Allied Product Manufacturing: NAICS 316
Wood Product Manufacturing: NAICS 321
Paper Manufacturing: NAICS 322
Printing and Related Support Activities: NAICS 323
Petroleum and Coal Products Manufacturing: NAICS 324
Chemical Manufacturing: NAICS 325
Plastics and Rubber Products Manufacturing: NAICS 326
Nonmetallic Mineral Product Manufacturing: NAICS 327
Primary Metal Manufacturing: NAICS 331
Fabricated Metal Product Manufacturing: NAICS 332
Machinery Manufacturing: NAICS 333
Computer and Electronic Product Manufacturing: NAICS 334
Electrical Equipment, Appliance, and Component Manufacturing: NAICS 335
Transportation Equipment Manufacturing: NAICS 336
Furniture and Related Product Manufacturing: NAICS 337
Miscellaneous Manufacturing: NAICS 339
https://www.bls.gov/home.htm

Automation Article

What is a Programmable Logic Controller?
What is a Microprocessor?
What is a Microcontroller?
Carnegie Mellon Robotics Academy
Breaking the Code on a Career in Cybersecurity (YouTube playlist)
European Union [EU] directive on security of network and information systems [NIS Directive]
North American Electric Reliability Corporation Critical Infrastructure Protection [NERC CIP]).
Chemical Facility Anti-Terrorism Standards [CFAT])
https://www.threatanalysis.com/2010/05/03/threat-vulnerability-risk-commonly-mixed-up-terms/
http://cyberphysicalsystems.org/ https://www.nist.gov/el/cyber-physical-systems

Presidential Policy Directive (PPD)-21 Critical Infrastructure Security and Resilience (2013)
Executive Order (EO) 13636 Improving Critical Infrastructure Cybersecurity (Issued Dec 2016).
Open Web Application Security Project
https://virginiacyberrange.org/

Appendix: Credentials, Course Sequences, and Career Cluster Information

Industry Credentials: Only apply to 36-week courses

- Automated Manufacturing Technology Examination
- Certified Production Technician (CPT) Program Examinations
- College and Work Readiness Assessment (CWRA+)
- Manufacturing Specialist Certification Examination
- Manufacturing Technician Level I Certification Examination
- Manufacturing Technology Assessment
- National Career Readiness Certificate Assessment
- Workplace Readiness Skills for the Commonwealth Examination

Concentration sequences: *A combination of this course and those below, equivalent to two 36-week courses, is a concentration sequence. Students wishing to complete a specialization may take additional courses based on their career pathways. A program completer is a student who has met the requirements for a CTE concentration sequence and all other requirements for high school graduation or an approved alternative education program.*

- Cybersecurity Fundamentals (6302/36 weeks)
- Cybersecurity in Manufacturing, Advanced (8496/36 weeks)

Career Cluster: Information Technology	
Pathway	**Occupations**
Information Support and Services	**Computer Numerical Control Programmer (CNC Programmer)** **Systems Analyst**
Network Systems	**Computer Security Specialist** **Computer Software Engineer**
Programming and Software Development	**Computer Software Engineer** **Programmer** **Systems Analyst**

Career Cluster: Manufacturing	
Pathway	**Occupations**
Manufacturing Production Process Development	**Industrial Engineer** **Industrial Engineering Technician** **Manufacturing Systems Engineer**

Career Cluster: Manufacturing	
Pathway	**Occupations**
	Network Designer **Programmer**
Production	**Automated Manufacturing Technician**
Quality Assurance	**Quality Control Technician**

Career Cluster: Science, Technology, Engineering and Mathematics	
Pathway	**Occupations**
Engineering and Technology	**Computer Hardware Engineer** **Computer Programmer** **Computer Software Engineer** **Engineering Technician** **Industrial Engineer** **Industrial Engineering Technician** **Manufacturing Systems Engineer** **Network and Computer Systems Administrator** **Network Systems and Data Communication Analyst** **Systems Analyst**